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ENVIRONMENTAL LEVELS OF RADIOACTIVITY
FOR THE OAK RIDGE AREA

(Report for Period July - December, 1968)

Compiled by the
Health Physics and Safety Section
Health Physics Division
OAK RIDGE NATIONAL LABORATORY

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Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are concentrated by evaporation and disposed of in deep wells. Low level liquid wastes are discharged, after preliminary treatment, to surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of scrubbers and filters.

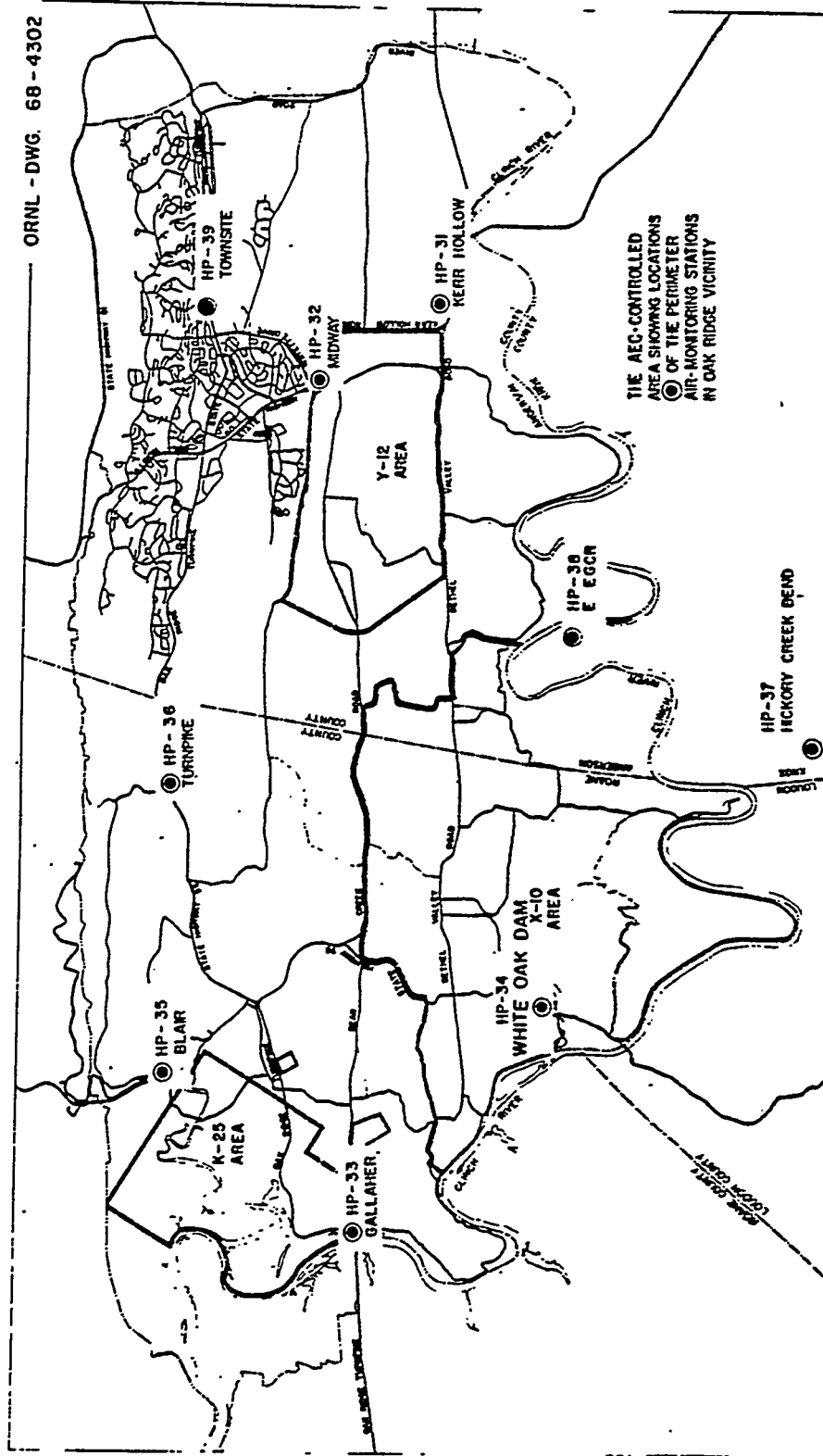
This report presents data on the environmental levels of radioactivity for the Oak Ridge area and compares the data with established maximum permissible concentrations.

Air Monitoring

Atmospheric contamination by radioactive materials occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of nine stations which encircle the plant area (Fig. 1) and provides data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 75 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Airborne radioactive iodine is monitored in the immediate environment of the plant area by passing air through a cartridge containing activated charcoal. Data collected are accumulated, tabulated, and averaged in units of $\mu\text{Ci/cc}$ of air sampled.

Milk Monitoring

Raw milk is monitored for ^{131}I and ^{90}Sr by the collection and analysis of samples from twelve sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge area. Four stations, located more remotely with respect to Oak Ridge Operations, are sampled at a rate of one station each week. The purpose of the



STATION SITES FOR PERIMETER AIR MONITORING SYSTEM

Figure 1

milk sampling program is two-fold: first, samples collected in the immediate vicinity of the Oak Ridge area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge Operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples.

Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, to the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for population groups in uncontrolled areas as specified by AEC Manual, Chapter 0524. The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

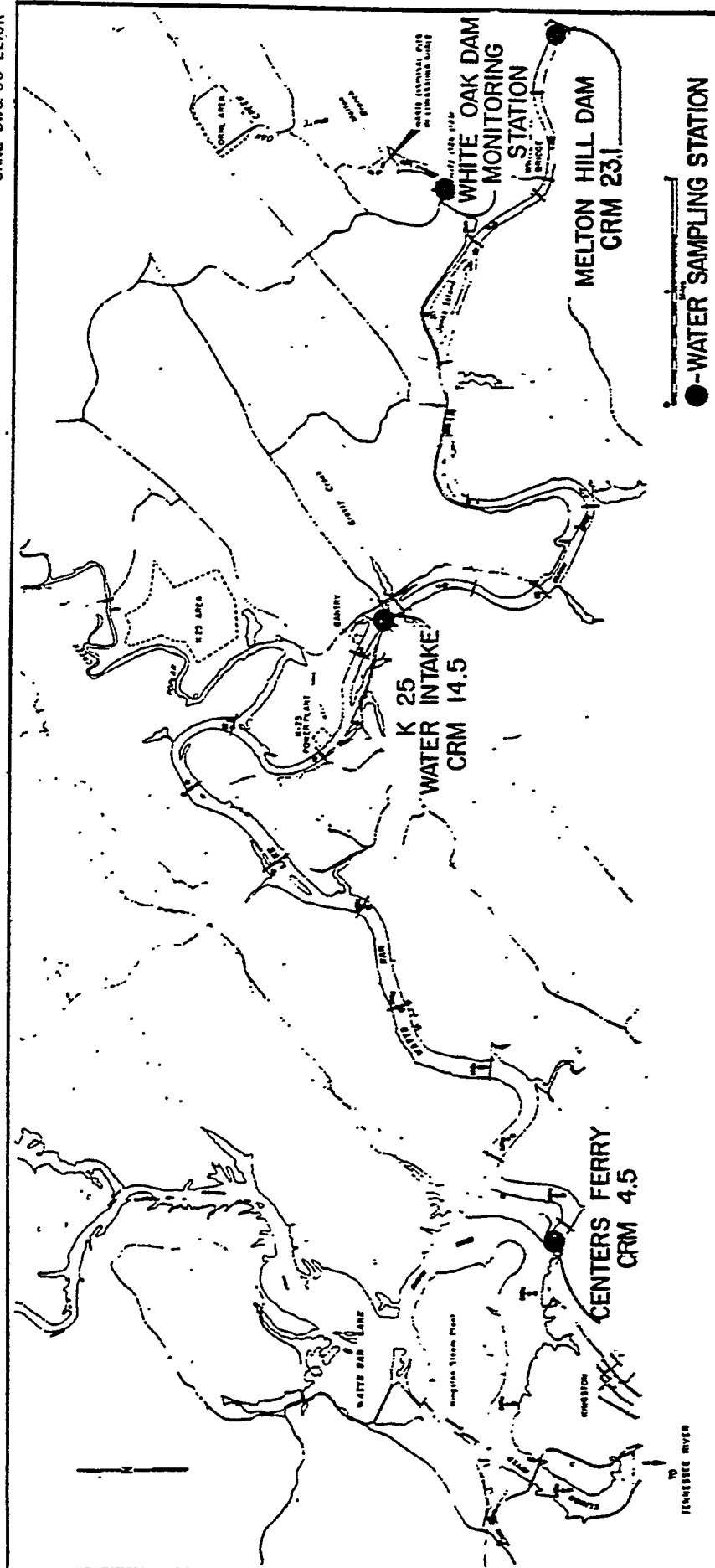
Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 3 and 4. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, for uranium and for the transuranic alpha emitters.

Analyses are made of the effluent for the long-lived radionuclides only, since cooling time and hold-up time in the waste effluent system are such that short-lived radionuclides are normally not present. The concentrations of those isotopes present in significant amounts are determined by analysis. A weighted average maximum permissible concentration for water, $(MPC)_w$, for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as specified by AEC Manual, Chapter 0524.¹ The average concentrations of gross beta activity in the Clinch River are compared to the calculated $(MPC)_w$ values.

The concentration of uranium is compared with the specific $(MPC)_w$ value for uranium.

¹AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.



WATER SAMPLING LOCATIONS

ORNL-DWG. 66-1810

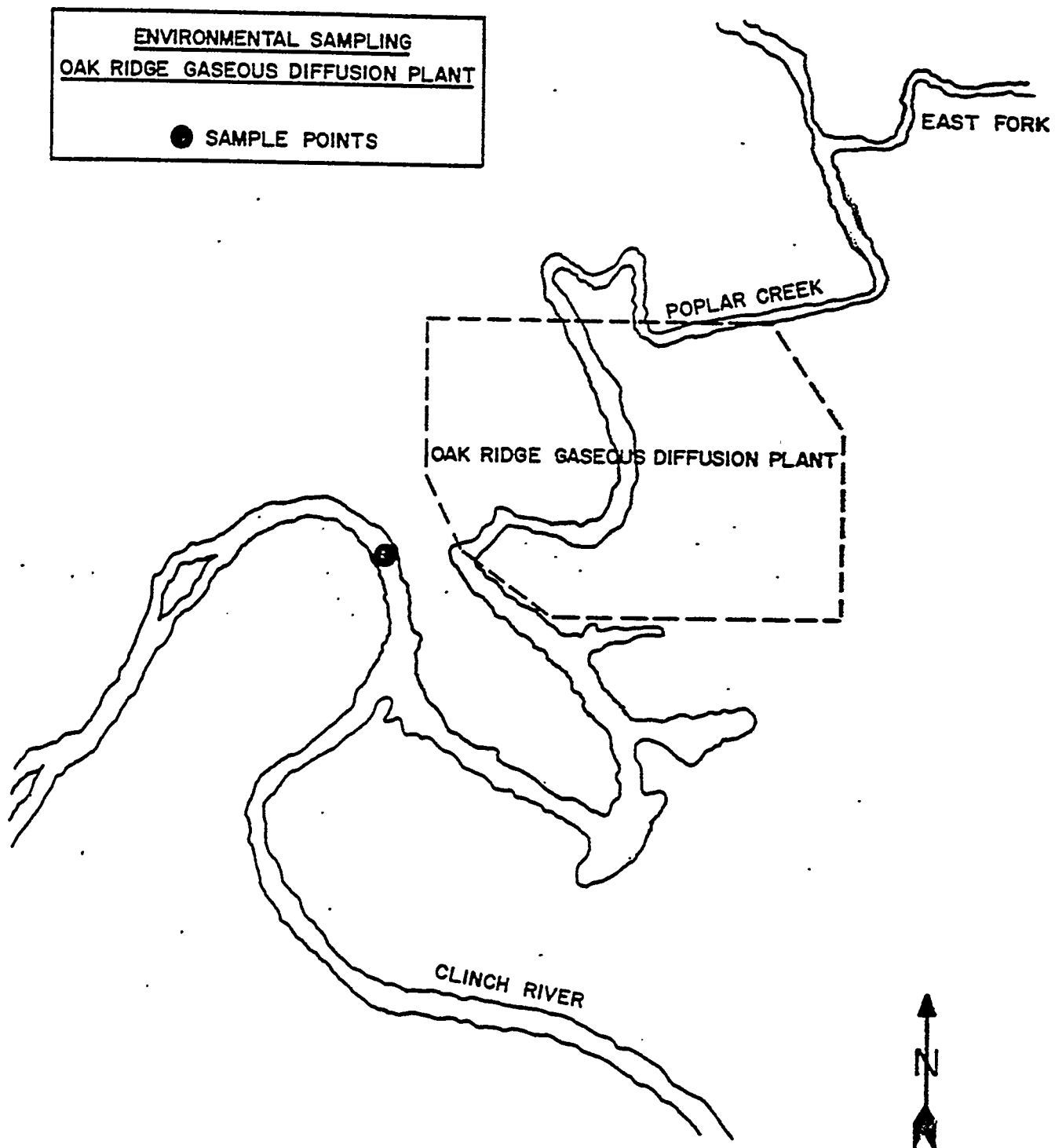


Figure 4

Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge area. Measurements are taken with a Geiger-Müller tube at a distance of three feet above the ground, and the results are tabulated in terms of mR/hr.

Discussion of Data

Data on the environmental levels of radioactivity for the second half of 1968 in the Oak Ridge and surrounding areas are presented in Table I through Table IX.

The average air contamination level for gross beta activity, as shown by the continuous air monitoring filter data, for both the immediate and remote environs of the plants was 0.10% of the maximum permissible concentration applicable to uncontrolled areas (Table I).

The average air contamination levels for gross alpha activity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.10% and 0.05%, respectively, of the $(MPC)_a$ for natural uranium for application to uncontrolled areas (Table II).

The average concentration of ^{131}I in air in the immediate environs of the plants was 0.02×10^{-12} $\mu Ci/cc$ (Table III). This is approximately 0.02% of the maximum permissible concentration for application to uncontrolled areas.

The average concentrations of ^{131}I in raw milk in the immediate and remote environs of the Oak Ridge area were 5.1 pCi/l and 5.0 pCi/l, respectively (Table IV). These levels fall within the limits of FRC Range I if one assumes the average intake per individual to be 1 liter of milk per day.

The average concentrations of ^{90}Sr in raw milk in the immediate and remote environs of the controlled area were 19 pCi/l and 17 pCi/l, respectively. These levels fall within the limits of FRC Range I for transient rates of daily intake of ^{90}Sr for application to the average of suitable samples of an exposed population.

The calculated average concentration of radioactivity in the Clinch River at Mile 20.8, the point of entry of most of the wastes, and the measured average concentration at Mile 4.5, near Kingston, Tennessee, were 0.33×10^{-8} $\mu Ci/ml$ and 0.76×10^{-8} $\mu Ci/ml$, respectively. These values are 0.31% and 0.34% of the weighted average maximum permissible concentrations $(MPC)_w$. The higher than normal value reported for the average concentration of radioactivity at Mile 23.1, Melton Hill Dam, was due primarily to ^{60}Co (Table VII). This contamination was found in the river upstream from the ORNL waste outfall and was the result of a source of contamination other than Oak Ridge Operations.

The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was 0.01×10^{-10} $\mu\text{Ci}/\text{ml}$ which is $< 0.01\%$ of the weighted average $(\text{MPC})_w$ value.

The average concentration of natural uranium materials in the Clinch River, reflecting the effects of all Oak Ridge plants, was $< 0.01\%$ of the $(\text{MPC})_w$ for uranium.

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge area was $0.012 \text{ mR}/\text{hr}$, which is approximately the same as the level measured in the early period prior to Oak Ridge Operations.

Conclusion

Surveillance of the radioactivity in the Oak Ridge environs indicated that the radioactivity levels were not significantly different from other areas of East Tennessee. Only very low level radioactivity is being released to the environment from plant operations and the resulting concentrations in both the atmosphere and surface streams of the Oak Ridge environment are well below established maximum permissible concentrations and intake guides for the neighboring population.

TABLE I
CONTINUOUS AIR MONITORING DATA

Long-Lived Gross Beta Activity of
Particulates in Air

July - December, 1968

Station Number	Location	Number of Samples Taken	Units of 10^{-12} $\mu\text{Ci/cc}$			% (MPC) _a ^c
			Maximum ^a	Minimum ^b	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	26	2.5	0.32	1.1	0.11
HP-32	Midway Gate	26	2.9	<0.01	1.6	0.16
HP-33	Gallaher Gate	26	2.2	0.28	0.89	0.09
HP-34	White Oak Dam	26	2.1	0.30	0.96	0.10
HP-35	Blair Gate	26	3.3	0.24	1.1	0.11
HP-36	Turnpike Gate	151 ^d	2.6	0.30	1.2	0.12
HP-37	Hickory Creek Bend	26	2.0	<0.01	0.73	0.07
HP-38	East of EGCR	26	2.4	0.54	1.1	0.11
HP-39	Townsite	26	1.6	<0.01	0.85	0.09
Average			2.4	0.17	1.0	0.10
<u>Remote Stations</u>						
HP-51	Norris Dam	26	2.4	0.23	0.96	0.10
HP-52	Loudoun Dam	25	2.6	0.27	1.1	0.11
HP-53	Douglas Dam	26	2.6	0.31	1.0	0.10
HP-54	Cherokee Dam	25	2.1	0.11	0.82	0.08
HP-55	Watts Bar Dam	25	2.4	0.12	0.97	0.10
HP-56	Great Falls Dam	26	2.7	0.22	1.1	0.11
HP-57	Dale Hollow Dam	26	2.5	0.24	0.93	0.09
HP-58	Knoxville	21	2.6	0.15	1.1	0.11
Average			2.5	0.21	0.99	0.10

^aMaximum weekly average concentration.

^bMinimum weekly average concentration.

^c(MPC)_a is taken to be 10^{-10} $\mu\text{Ci/cc}$ as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

Samples collected five days per week beginning 9/20/68.

TABLE II
CONTINUOUS AIR MONITORING DATA

Long-Lived Gross Alpha Activity of
Particulates in Air

July - December, 1968

Station Number	Location	Number of Samples Taken	Units of 10^{-13} $\mu\text{Ci/cc}$			% (MPC) _a ^c
			Maximum ^a	Minimum ^b	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	26	0.04	< 0.01	0.02	0.10
HP-32	Midway Gate	26	0.05	< 0.01	0.02	0.10
HP-33	Gallaher Gate	26	0.04	< 0.01	0.02	0.10
HP-34	White Oak Dam	26	0.04	< 0.01	0.01	0.05
HP-35	Blair Gate	26	0.08	< 0.01	0.02	0.10
HP-36	Turnpike Gate	151 ^d	0.11	< 0.01	0.04	0.20
HP-37	Hickory Creek Bend	26	0.04	< 0.01	0.02	0.10
HP-38	East of EGCR	26	0.02	< 0.01	0.01	< 0.01
HP-39	Townsite	26	0.04	< 0.01	0.02	0.10
Average			0.05	< 0.01	0.02	0.10
<u>Remote Stations</u>						
HP-51	Norris Dam	26	0.02	< 0.01	0.01	0.05
HP-52	Loudoun Dam	25	0.05	< 0.01	0.02	0.10
HP-53	Douglas Dam	26	0.04	< 0.01	0.01	0.05
HP-54	Cherokee Dam	25	0.05	< 0.01	0.01	0.05
HP-55	Watts Bar Dam	25	0.04	< 0.01	0.01	0.05
HP-56	Great Falls Dam	26	0.03	< 0.01	0.01	0.05
HP-57	Dale Hollow Dam	26	0.03	< 0.01	0.01	0.05
HP-58	Knoxville	21	0.14	< 0.01	0.03	0.15
Average			0.05	< 0.01	0.01	0.05

^aMaximum weekly average concentration.

^bMinimum weekly average concentration.

^c(MPC)_a used is 20×10^{-13} $\mu\text{Ci/cc}$, the MPC for natural uranium as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

^dSamples collected five days per week beginning 9/20/68.

TABLE III
CONCENTRATION OF ^{131}I IN AIR
AS MEASURED BY THE PERIMETER AIR MONITORING STATIONS

July - December, 1968

Number of Samples	Units of $10^{-12} \mu\text{Ci/cc}$			% (MPC) _a ^b
	Maximum	Minimum ^a	Average	
234	0.74	< 0.01	0.02	0.02

^a Minimum detectable amount of ^{131}I is 20 d/m. At the average sampling rate used, this corresponds to approximately $0.010 \times 10^{-12} \mu\text{Ci/cc}$. In averaging, one-half of this value, 10 d/m, is used for all samples showing a total amount of ^{131}I less than 20 d/m.

^b (MPC)_a is taken to be $1 \times 10^{-10} \mu\text{Ci/cc}$ as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

TABLE IV
CONCENTRATION OF ^{131}I IN RAW MILK

July - December, 1968

Location	pCi/l		
	Maximum	Minimum ^a	Average
Immediate Environs	15	< 10	5.1
Remove Environs	< 10	< 10	5.0

^a Minimum detectable concentration of ^{131}I is 10 pCi/l. In averaging, one-half of this value, 5 pCi/l, was used for all samples showing a concentration less than 10 pCi/l.

TABLE V
CONCENTRATION OF ^{90}Sr IN RAW MILK

July - December, 1968

Location	pCi/l		
	Maximum	Minimum ^a	Average
Immediate Environs	38	9.0	19
Remote Environs	23	12	17

^a Minimum detectable concentration of ^{90}Sr in milk is 2 pCi/l. In averaging, one-half of this value, 1 pCi/l, was used for all samples showing a concentration less than 2 pCi/l.

TABLE VI
 CALCULATED AVERAGE CONCENTRATION OF RADIOACTIVITY
 IN THE CLINCH RIVER AT MILE 20.8

July - December, 1968

Number of Samples Taken	Units of 10^{-7} $\mu\text{Ci/ml}$			% of $(\text{MPC})_w$
	Maximum ^a	Minimum ^b	Average	
181	0.18	0.008	0.033	0.31

^a Maximum weekly average.

^b Minimum weekly average.

TABLE VII

AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS
IN THE CLINCH RIVER

July - December, 1968

Location	Units of 10^{-8} $\mu\text{Ci/ml}$						Average Beta Activity	$(\text{MPC})_w^a$	% of $(\text{MPC})_w$
	^{90}Sr	^{144}Ce	^{137}Cs	^{106}Ru	^{60}Co	$^{95}\text{Zr} - ^{95}\text{Nb}$			
Mi. 23.1 ^b	0.04	0.02	*	0.04	0.88	*	0.98	550	0.18
Mi. 20.8 ^c	0.05	< 0.01	0.01	0.04	< 0.01	< 0.01	0.33	100	0.31
Mi. 4.5	0.09	0.03	0.14	0.05	0.44	0.01	0.76	220	0.34

^aWeighted average $(\text{MPC})_w$ calculated for the mixture using $(\text{MPC})_w$ values for specific radionuclides specified by AEC Manual, Chapter 0524, Appendix, Annex I, Table II.

^bSampling station moved from Clinch River Mile 41.5 to Melton Hill Dam, CRM 23.1, about January 1, 1966.

^cValues given for this location are calculated values based on levels of waste released and the dilution provided by the river; they do not include amount of radioactive material (e.g., fallout) that may enter the river upstream from CRM 20.8.

*None detected.

TABLE VIII
URANIUM CONCENTRATION IN THE CLINCH RIVER

July - December, 1968

Sampling Point	Type of Analyses Made	No. of Samples ^a	Units of 10^{-8} $\mu\text{Ci/ml}$			% (MPC) _w
			Maximum ^b	Minimum ^b	Average ^b	
Downstream from ORGDP	Uranium Concentration	2	< 0.1	< 0.1	< 0.1	< 0.01

^aNormal Sampling Frequency: Continuous, composited over six-month period.

^bNo uranium was detected in Clinch River water samples during this period. Minimum detectable concentration of uranium in river water is 0.1×10^{-8} $\mu\text{Ci/ml}$.

TABLE IX
EXTERNAL GAMMA RADIATION LEVELS

· mR/hr

July - December, 1968

Station Number	Location	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Solway Gate	0.016	0.009	0.013	0.011	*	*	0.012
2	Y-12, East Portal	0.012	0.012	0.010	0.012	*	*	0.012
3	Newcomb Road, Oak Ridge	0.012	0.012	0.012	0.011	*	*	0.012
4	Gallaher Gate	0.011	0.012	0.011	0.009	*	*	0.011
5	White Wing Gate	0.012	0.013	0.009	0.010	*	+	0.011
Average		0.012	0.012	0.011	0.011	*	*	0.012

Note: These readings were taken with a calibrated Geiger-Müller tube at a distance of three feet above the ground.

The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mR/hr.

* No measurement made.

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